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Tracking and Positioning Of Mobile Systems in Telecommunication Networks

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***Abstract*— In today's fast generation the Mobile Positioning technology has became a vital role in area of research. The evolution to location-dependent services and applications in wireless systems continues to require the development of more accurate and reliable mobile positioning technologies. Mobile Positioning in cellular networks will provide several services such as, locating stolen mobiles, emergency calls, different billing tariffs depending on where the call is originated, and methods to predict the user movement inside a region. The major challenge to accurate location estimation is in creating techniques that yield acceptable performance when the direct path from the transmitter to the receiver is intermittently blocked. This is the Non-Line-Of Sight (NLOS) problem, and it is known to be a major source of error since it systematically causes mobile to appear farther away from the Base station (BS) than it actually is, thereby increasing the positioning error. In this paper, we present a simple method for mobile telephone tracking and positioning with high accuracy. Through this we will discuss some technology used for mobile positioning and tracking.**

***Index Terms*— Mobile Technology, Need for Tracking, Positioning techniques, GPS, Location Tracking Curve method.**

I. INTRODUCTION

Various location-based services in wireless communication networks depend on mobile positioning. Mobile positioning technology has become an important area of research and it is applied to the key reasons for the tremendous research interest in personal positioning technologies in cellular networks. The evolution to location-dependent services and applications in wireless systems continues to require the development of more accurate and reliable mobile positioning technologies [2]. In terms of terminology the mobile positioning and mobile location are similar but conversely there are two different things, in which the mobile positioning refers to determining the position of the mobile device where as mobile location refers to the location estimate derived from the mobile positioning operation. Mobile positioning in cellular networks will provide several services such as, locating stolen mobiles, emergency calls, different billing tariffs depending on where the call is originated, and methods to predict the user movement inside a region. In a cellular mobile telecommunication network, the whole service area is divided into a several coverage areas having their respective Base Stations Each base station coverage area is called a cell [8]. Each base station is provided has a frequency of a range between 450 to900 MHz frequency and no two adjacent cells must have same frequencies. There are various means of mobile positioning, which can widely be divided into two major categories – network based and handset based positioning methods.

A. *Network-based Mobile Positioning Technology*

The Network based technology is used for the mobile network, in conjunction with network-based position determination equipment in which it is used to position the mobile device. This technique utilizes the service provider's network infrastructure to identify the location of the handset. The advantage of Network-based techniques is that it can be implemented tending without affecting the handsets. These are basically the Multilateral (multiple Base Stations measuring simultaneously), unilateral (MS measures multiple BSs) and examples are the Angle of Arrival (AOA) and Time of Arrival (TOA) / Time Difference of Arrival (TDOA) approaches.

B. Handset-based Mobile Positioning Technology

This technique determines the location of the handset by putting its location by cell identification, signal strengths of neighbouring cells etc. And the handset itself is the primary means of positioning the user, although the network can be used to provide assistance in acquiring the mobile device and/or making position estimate determinations based on measurement data

II. NEED FOR MOBILE TRACKING

Mobile Phone Tracking refers to the achieving of the current position of a mobile phone in a moving or stationary condition. Mobile tracking locates the distance between mobile telephone network and the base stations. it determines the arrival time of the signals at base stations and the location of mobile telephone. This location service is provided generally by a location data processor included in a base station controller (BSC). Upon a request for service about the location of a specific mobile subscriber, the BSC selects the three adjacent BSs surrounding the mobile telephone for use in the location service, and these selected base stations are ready for communication with the mobile telephone. The positioning of the mobile user could provide services like

- Emergency service for subscriber safety.
- Location sensitive billing.
- Cellular Fraud detection.
- Intelligent transport system services.
- Efficient and effective network performance and management.

III. GLOBAL POSITIONING SYSTEM (GPS)

A GPS tracking system can be used to give both real-time and historical navigation data as it uses the **Global Navigation**

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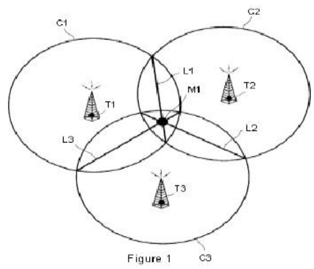
Satellite System (GNSS) network. The GNSS network incorporates a range of satellites that use microwave signals, and these signals are then analyzed to determine the location of the cell phone. A GPS device receives signals from the GPS satellites, and if it can receive strong signals from three or more satellites, then the location is calculated accurately [6]. Many mobile phones and tablets have integrated GPS (Global Positioning System) tracking systems that provide independent mobile tracking through the device. GPS tracking works via a network of satellites in orbit to determine the location and time of the device. The data can only be sent when there are four or more satellites within line of sight of the device. GPS tracking services are often referred to as location-based services (LBS), as well. While some older mobile devices may not have GPS tracking (apart from being activated in an emergency), most devices now include GPS features and applications as standard. One such application of GPS tracking is being able to find a lost mobile. **Global Positioning Tracking** uses the concept of triangulation to calculate the location of the cell phone. Satellites and the cell phone are used as the landmarks for this purpose. An important aspect of GPS tracking is that a GPS device cannot send signals; it can only receive them. So, satellites and the GPS system within the cell phone are two basic necessities for successful GPS tracking. However, if the signals are weak, it could be difficult to accurately locate the cell phone. Today, GPS tracking is used in business and home life. For example, a delivery company can use GPS tracking in order to know where all its delivery trucks are. This allows the business to ensure that all employees are where they should be during working hours, and the company can also let customers know the location of a truck that is due to deliver to their house.

IV. DIRECTION BASED POSITIONING

A. TIME OF ARRIVAL (TOA)

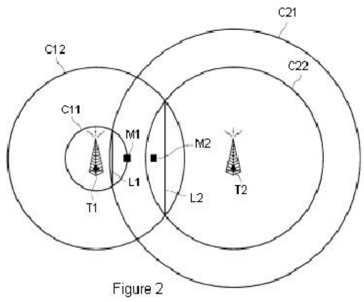
In cellular mobile communication the signals transmission and reception exists between a mobile unit and the base stations [4]. The distance which calculates the mobile telephone and the base stations determines the time of arrival method in which it is assumed to locate the intersection point of three circles having the radius of the distances between the base stations and the mobile telephone as shown in below fig



"Fig."1: Time of Arrival method locating mobile telephone

B. TIME DIFFERENCE OF ARRIVAL (TDOA)

The Time Difference of Arrival (TDOA) technique is one of the most important techniques for cellular-type wireless communication systems. TDOA techniques are based on estimating the difference in the arrival times of the signal from the source at multiple receivers. This method offers many advantages over other competing techniques. Since this technique does not require any special type of antennas, it is cheaper to put in place than the Direction of Arrival (DOA) finding methods. It can also provide some immunity against timing errors if the source of major signal reflections is near the mobile. If a major reflector affects the signal components going to all the receivers, the timing error may get cancelled or reduced in the time difference operation. Hence, TDOA methods may work accurately in some situations where there is no line of sight signal component.

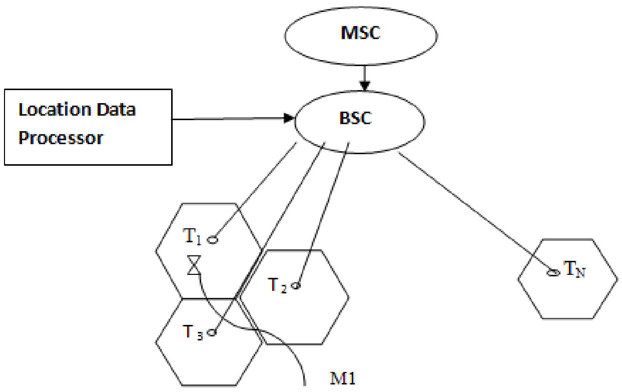


"Fig."2: Time of difference of arrival locating method mobile telephone

From the above figure the Time- Difference- Of- Arrival (TDOA) measures the distances between multiple pairs of reference points with known locations. The mobile telephone M1, M2 and the base stations T1, T2 are overlapped across area. One approach to locating the mobile telephone M1 in the overlap area 1 is to use a common chord, as shown in Figure 2. When at least three circles C1, C2, and C3 are overlapped over an area without meeting at one point, the mobile telephone M1.The L1, L2 are the chords and defined by the intersection between the circles C11 and C21. But if the path between the first mobile telephone M1 and the second base station T2 is in an non line of sight condition and the path between the first mobile telephone M1 and the first BS T1 is in a line-of-sight (LOS) condition, the common chord L1 is positioned far left from the actual location of the mobile telephone M1.

V. LOCATION TRACKING CURVE METHOD

A.PROPOSAL



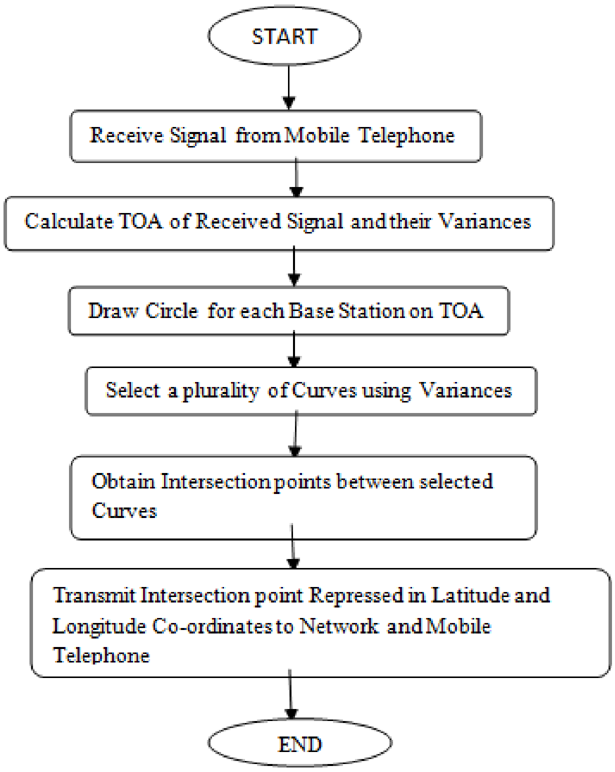
"Fig."3: Typical mobile telecommunication network

In a cellular mobile telecommunication network, the whole service area is divided into a several coverage areas having respective base stations. The base station controller (BSC) for

controlling the Base Stations T_1, T_2, so on upto T_N, and a mobile switching center (MSC) for connecting the BSC to another a PSTN (Public Switched Telephone Network). The MSC can reduce the time required for calling a subscriber by locating the cell of the subscriber. The following steps as follows:

1. Each base station nearer to a mobile telephone receives a predetermined signal from the mobile telephone and calculates the distance between the mobile telephone and the base station and the variances of time arrival of the signal at the base station.
2. A circle is drawn to have a radius being the distance and the coordinates of the base station being the centre of the circle.
3. A pair of the first and the second base stations is selected among the base stations. A several location tracking curves connecting two intersection points between the selected circles corresponding to the first and the second base stations are drawn. One of the location tracking curves is selected using the variances of the first and the second base stations;
4. he steps 2. and 3. are repeated for the other pairs of the base stations;
5. The intersection points are obtained among the location tracking curves selected in step 4.

The location of the mobile telephone is determined using the coordinates of the intersection points obtained in step 5.



"Fig."4: Flowchart showing the steps involved in locating a mobile telephone

The several location tracking curves are parts of circles with centers near to the base station with smaller variances between the first and the second base stations. The circles formed by the location tracking curves have the centers on a line connecting the coordinates of the first and the second base stations. The larger variances between the variances of the first and the second base stations are compared to the variances of the several location tracking curves, and one of the location tracking curves is selected according to the comparison result. The location coordinates of the mobile telephone are determined by averaging the coordinates of the intersection points obtained in step (6).

B. DESCRIPTION

When a location service is requested about a specific mobile telephone by a user or a network, the location data processor draws two circles C1 and C2 with their respective centers set at Base Stations T1 and T2 based on the TOAs of a signal transmitted from the corresponding mobile telephone M1 or M2 to the two BSs T1 and T2 located near the mobile telephone M1 or M2. The two circles C1 and C2 define a common chord L1.

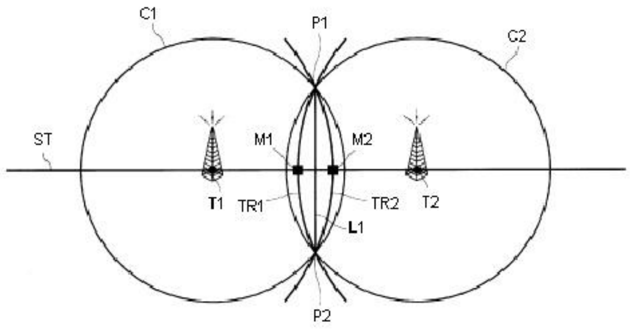


Figure 5

"Fig." 5: Proposed method for mobile telephone location

However, if each mobile telephone M1 or M2 is placed in a different propagation environment with respect to the BSs T1 and T2, the location of the mobile telephone M1 or M2 cannot be determined by the common chord L1. Therefore, we use location tracking curves TR1 and TR2 connecting the same two intersection points P1 and P2 of the two circles C1 and C2, instead of the common chord L1. The process of determining the location tracking curves will be explained later. The two curves TR1 and TR2 have their middle points intersecting the line ST, which connects the positions of the two Base Stations. T1 and T2 and the parts of two circles C1 and C2 drawn to connect the two intersection points P1 and P2. Instead of the common chord L1, the location data processor uses the curve TR1 for the mobile telephone M1 and the curve TR2 for the mobile telephone M2. It prevents the location error caused by the multi-path fading or the NLOS path characteristics. If the radio propagation environment between the mobile telephone and the BS is poor due to the multi-path fading or the NLOS effects, the TOA of the received signal has error. The TOA error can be compensated by appropriately selecting a desired curve (reference circle).

C. DETERMINATION OF LOCATION TRACKING CURVE

The NLOS (Non Light of sight) environment has been compared with the LOS environment and we see that the variances of the TOAs of a signal transmitted from a mobile telephone are higher in the NLOS environment. By knowing this, appropriate curves can be selected by comparison

between the variances of TOAs of an input signal [4]. That is, the mobile telephone is nearer from the common chord L1 to the one with the larger variances out of the two BSs in Figure 5. Therefore, the BS with the smaller variances should be selected to draw reference circles based on the variances. For example, since the first mobile telephone M1 is near the first BS T1, the variances of the TOAs of a signal transmitted from the mobile telephone M1 at the first BS T1 will be higher than those of the signal at the second BS T2. Hence, the reference circle C1 is obtained around the second BS T2 with smaller variances.

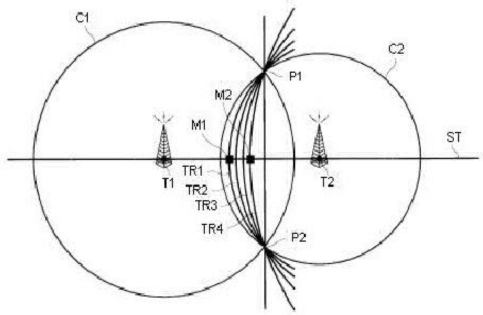


Figure 6

"Fig." 6: Determination of location tracking curve.

From above fig., assuming that the first and the second BSs T1 and T2 selected for use in the location tracking are present at positions (x1, y1) and (x2, y2), respectively, in the second-dimensional coordinates, the location data processor draws the two circles C1 and C2 with the coordinates (x1, y1) and (x2, y2) of the two BSs T1 and T2 at their centers. The curve connects the two points P1 and P2 at which the two circles C1 and C2 intersect each other. The coordinates of the intersection points P1 and P2 are (xA, yA) and (xB, yB), respectively. Since the mobile telephone is near the first BS T1 with respect to the common chord L1, the variances of the TOAs of a signal transmitted from the mobile telephone at the first BS T1 will be larger than those of the signal at the second BS. Therefore, reference circles TR1 to TR4 are drawn with respect to the second BS T2 with smaller variances, as shown in Figure 7.
The coordinates of the reference circle can be obtained (using minimum variance) which has its center on the line ST passing through (x1, y1) and (x2, y2) and passes through (xA, yA) and (xB, yB). Selecting the center of the reference circle is significant as the mobile telephone is located on the reference circle. The location data processor selects the desired curves (reference circles) with respect to the several BSs selected for location tracking. In Figure 6, as the real location of the mobile telephone deviates farther from the circle C2 with the second BS T2 at its centre, the centre of a reference circle is farther from the location of the second BS T2. That is, the centre of a desired reference circle is farther from the second BS T2 in the case of a third mobile telephone M3 (curve C3) than in the case of a fourth mobile telephone M4.

VI. CONCLUSION

Our proposal is advantageous in that the location of a mobile telephone can be accurately tracked even in the multi-path fading and the NLOS environment, by using more accurate tracking curves connecting the intersection points among circles with the radii being the distances between corresponding BSs and the mobile telephone in a cellular mobile communication system. We have described about accurate positioning of mobile telephones, which can be used for several applications. The important considerations to be undertaken while selecting a location based technology are location accuracy, implementation cost, reliability, increasing functionality.

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